Insights for the Future of Arctic Sea Ice from the CMIP6 lig127k Experiment

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New to CMIP6 is the Tier 1 lig127k experiment, designed to address the climate responses to stronger orbital forcing than the mid-Holocene experiment, using the same state-of-the-art models and following a common experimental protocol. We present a multi-model ensemble of 17 climate models, all of which (except for two) have also completed the CMIP6 DECK experiments, looking at the lig127k Arctic’s responses across models and the relationships with each model’s Equilibrium Climate Sensitivity (ECS), preindustrial sea ice thickness and 127ka temperature anomalies.

Boreal insolation anomalies at 127 ka enhance the seasonal cycle of Arctic sea ice, though with notable differences among the models. The consensus from the lig127k sea ice distributions is a reduced minimum (August-September) summer sea ice extent in the Arctic as compared to the piControl simulations. Sea ice remains above 15% concentrations over the central Arctic Ocean in all but one of the lig127k simulations. More than half of the models simulate a retreat of the Arctic minimum ice edge similar to the average of the last 2 decades. The lig127k minimum Arctic sea ice area anomalies show a strong negative correlation with the Arctic (60-90°N) annual surface temperature anomalies but only a weak correlation with the corresponding June-July-August (JJA) temperature anomalies. Memory in the ocean and cryosphere provide feedbacks to maintain larger positive temperature anomalies, December-January-February (DJF) and annually, in the Arctic than in JJA. The models contributing to the lig127k ensemble have an ECS varying from 2.1 to 5.3°C. There is a notable relationship between the ECS and simulation of lig127k minimum Arctic sea ice area. With very limited Arctic sea ice proxies for 127 ka, and with evolving interpretation of the relationships of these proxies with sea ice coverage, it is still difficult to rule out the high or low values of ECS from the proxy data.